CLAIMS

1. – 52. (CANCELLED)

53. (CURRENTLY AMENDED) A method of estimating arterial delay and arterial dispersion (t, α, σ) values for outputting blood perfusion indices for a region of interest (ROI) by ~~from~~ operating a computer program on intensity data [[in]] input to a computer comprising:

a. ~~using a computer to apply~~ applying a first gamma-variate function (GVF) to an arterial input function (AIF_a) ~~using a computer~~ to provide an estimated first model of a vascular transport function $h_a(t)$, wherein for $t < t_1$, $h_a(t) = 0$ and for $t \geq t_1$, $h_a(t) = \frac{1}{\sigma_1}(t-t_1)^{\alpha_1} e^{-(t-t_1)/\sigma_1}$, wherein t_1 is the transit time of a contrast agent from a measured initial said AIF_a to a region of interest (ROI) and σ_1 is an ~~estimating~~ estimate of an initial ~~delay~~ dispersion value of said contrast agent, wherein said $\sigma_1=(t_1)(\beta_1)/(1-\beta_1)$, wherein said β_1 is a known relative dispersion value having a range from 0 to 1;

b. ~~using a computer to convolve~~ convolving $AIF_a(t)$ with said $h_a(t)$ with $\alpha_1=0$ ~~using a computer~~ for obtaining an arterial input function $AIF_t(t) = AIF_a(t) \otimes h_a(t)$ with $\alpha_1=0$ at said ROI;

c. ~~using a computer to estimate~~ estimating a blood flow rate F_t and a tissue impulse residue function $R_e(t)$ ~~using a computer~~ by deconvolving a concentration curve $C(t) = (F_t/k_H)AIF_t(t) \otimes R_e(t)$, wherein k_H is a ~~hermatocrit~~ hematocrit correction constant having a known value, wherein

a tissue transport function $h_e(t)$ is determined by $h_e(t) = -dR_e(t)/dt$;

~~d. using a computer to optimize said mean transit time and dispersion~~ ~~(t_2, α_2, σ_2)~~ ~~values using a least squares method from an estimated transport function~~ ~~$h_e(t)$~~~~; and~~

~~e. using a computer to output inputting said estimated and optimized calculated tissue mean transit time and dispersion~~ ~~(t_2, α_2, σ_2)~~ ~~values from an estimated transport function~~ ~~$h_e(t)$~~ ~~for input to a simulated transport function~~ ~~$h_s(t)$~~~~, wherein a simulated tissue impulse residue function~~ ~~$R_s(t)$~~ ~~is determined, wherein a simulated concentration curve~~ ~~$C_s(t)$~~ ~~is fitted to said measured~~ ~~$C(t)$~~ ~~and quantitative said blood perfusion indices are calculated, wherein each said step is performed by a suitably programmed computer.~~

d. determining a simulated transport function $h_s(t)=\frac{1}{A_2}(t-t_2)^{\alpha_2}e^{-(t-t_2)/\sigma_2}$ when $t \geq t_2$ and $h_s(t)=0$ when $t<t_2$, wherein $A_2 = \sigma_2^{1+\alpha_2}\Gamma(1+\alpha_2)$, wherein said $h_s(t) = \frac{1}{A_2}t^{\alpha_2}e^{-t/\sigma_2}$ when said $t_2=0$, or said $h_s(t) = \frac{1}{\sigma_2}e^{-(t-t_2)/\sigma_2}$ when said $\alpha_2 = 0$, wherein said σ_2 is a dispersion of said $h_e(t)$ and said t_2 is a mean transit time of said $h_e(t)$, wherein when said $\alpha_2 = 0$ a peak height (PH)=$1/\sigma_2$ and a mean transit time (MTT)=$t_2+\sigma_2$ are used to determine said σ_2;

e. determining a simulated tissue impulse residual function (IRF) $R_s(t) = 1 - \int_0^t h_s(\tau)d\tau$, wherein a simulated contrast agent concentration $C_s(t)$ is determined by $C_s(t) = (F_t/k_H)AIF_t(t) \otimes R_s(t)$; and

f. fitting said simulated $C_s(t)$ to said $C(t)$ by iteratively minimizing $\boldsymbol{S}$ using a least squares method defined by $S = \sum_t (C(t) - C_s(t))^2$, wherein said iteratively mimimizing $\boldsymbol{S}$ comprises reducing the number of adjustable parameters, wherein said adjustable parameters are reduced to five by fixing said $\alpha_1=0$ and said $t_2 = 0$, or by fixing said $\alpha_1=0$ and said $\alpha_2=0$, and wherein said adjustable parameters are further reduced to four by fixing said relative dispersion $\beta_1=\sigma_1/(\sigma_1+t_1)$ of said $h_e(t)$ resulting in said σ_1 dependent on said t_1;

wherein each said step is performed by a suitably programmed computer.

54. (CURRENTLY AMENDED) The method of claim 53, wherein said intensity data is generated by administering a contrast agent to a body lumen of a body during a dynamic imaging scan, wherein said body lumen comprises an artery or a vein, wherein an image response from said contrast agent is recorded to computer data storage in a computer.

55. (PREVIOUSLY PRESENTED) The method of claim 53, wherein said $C(t)$ is a temporal concentration of said contrast agent obtained from said intensity data, wherein said intensity data comprises contrast images sequentially acquired from a region in a body, whereby said contrast agent concentration is plotted versus time.

56. (CURRENTLY AMENDED) The method of claim 53, wherein said AIF_a is

based on a measured ~~early arrival~~ contrast ~~agent peak~~ intensity profile from a feeding blood vessel to said ROI.

57. (CURRENTLY AMENDED) The method of claim 53, wherein said AIF_a is scaled upward according to a venous input function (VIF), wherein said VIF is based on a measured ~~late arrival~~ contrast ~~agent peak~~ intensity profile from a ~~large~~ vein draining from said ROI.

58. (PREVIOUSLY PRESENTED) The method of claim 53, wherein said estimated transit time t_l is the transit time of said contrast agent from a measured initial said AIF_a of said contrast agent C(t) in a body lumen to said ROI, wherein said t_l is estimated from plots of said AIF_a versus time and said C(t) versus time.

59. (PREVIOUSLY PRESENTED) The method of claim 53, wherein said $h_a(t)$ is calculated using said estimated transit time t_l and said estimated dispersion value σ_l, wherein $h_a(t)$ with $\alpha_l=0$ is plotted versus time.

60. - 65. (CANCELED)

66. (CURRENTLY AMENDED) The method of claim 53, wherein said $AIF_t(t)$ is measureable in a ~~small~~ lumen showing a delay relative to said $AIF_a(t)$, wherein optimized values for said σ_l and said t_l are determined by fitting said ~~simulated~~

convolved $AIF_t(t)$ to said measured $AIF_t(t)$, wherein said relative dispersion β_1 is determined and applied to all other said intensity data of said ROI using said β_1, wherein a ~~more robust~~ fitting process is provided by a reduced number of parameters for optimization.

67. (CURRENTLY AMENDED) The method of claim 66, wherein when said relative dispersion β_1 is determined, said vascular transport function $h_a(t)$ is described by a single variable said t_1 with a constant said β_1, wherein a two-step method is used to determine said delay and said dispersion values comprising:

   a. deriving an initial tissue impulse residue function $R_0(t)$ by deconvolving $C(t) = (F_0/k_H)AIF_a(t) \otimes R_0(t)$ using a model-free ~~singular value decomposition (SVD)~~ deconvolution method, wherein said time delay t_1 is determined by a maximum position of said $R_0(t)$ at $R_{0\,max}(t=t_1)$; and

   b. determine said $AIF_t(t)$ at an input of said ROI using said $h_a(t)$ with said t_1 and said β_1 held constant, wherein said σ_1 is determined.

68. (CURRENTLY AMENDED) The method of claim 67, wherein a value of tissue blood flow F_t and a corrected impulse residue function $R_e(t)$ are obtained by deconvolving $C(t) = (F_t/k_H)AIF_t(t) \otimes R_e(t)$ using said ~~SVD~~ model-free deconvolution method, wherein said perfusion indices are determined from a curve of said $R_e(t)$, wherein MTT= $\int_0^\infty R_e(\tau)d\tau$,

$BF=F_t$, and $BV=BF*MTT$.

69. (CURRENTLY AMENDED) The method of claim 53, wherein said contrast agent is in a tissue ROI having a tissue mean transit time τ, wherein a tissue impulse residue function is approximated by the relation $R(t > \tau) = Ee^{-k(t-\tau)}$ and $R(t \leq \tau) = 1$, wherein E is an extraction fraction of said contrast agent in said tissue, wherein k is a constant clearance rate of said contrast agent diffusing from said tissue having a relation $k = E*F_t/V_e$, wherein V_e is the volume fraction of extravascular and extracellular space (EES) in said tissue.

70. (CURRENTLY AMENDED) The method of claim 69, wherein said tissue impulse residue function $R_s(t)$ of said simulated concentration curve $C_s(t)$ is replaced by an average impulse residue function that incorporates said contrast agent leaked out of a blood vessel into said tissue and gradually clearing from said tissue, wherein said simulated concentration curve $C_s(t)$ is fitted to said measured C(t) and ~~quantitative~~ said blood perfusion indices are calculated, wherein said E and said V_e are additional parameters optimized with other adjustable parameters using a least squares method.